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To: Chris Scruton (CEC)
From: Steve Wiel
Subject: **Cool Roof Colored Materials**: Monthly Progress Report for November 2002
CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of November 30, 2002 is presented in Attachment 1.

HIGHLIGHTS

- Seven sites have been selected for exposing metal, tile, and asphalt shingle roof products in the diverse climates of California.
- Rick Olson and consortium members of the Roof Tile Institute submitted a written agreement to ORNL for the supply of roof material and labor to set up two demonstration homes in the Sacramento area.
- We have identified another company, Mike Evans Construction, which is interested in collaborating with us and is planning to build twelve homes within the Sacramento city limits. The walls will be insulated concrete foam (ICF) that Sacramento Municipal Utility District (SMUD) is subsidizing in exchange for acquiring thermal performance data. Further details will be given in December as ORNL continues discussions with SMUD and Evans Construction.

Tasks

- 1.1 Attend Kick-Off Meeting
This Task is completed.
- 1.2 Describe Synergistic Projects
This Task is completed.
- 2.1 Establish the Project Advisory Committee (PAC)
This task is essentially completed. However, based on the comments received at the PAC meeting, we will try to add to the PAC two more members representing consumers of cool roofing materials.
- 2.2 Software Standardization

(No activity.)

2.3 PAC Meetings

(No activity.)

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance

We have made theoretical refinements that have significantly advanced our ability to accurately compute the Kubelka-Munk scattering and absorption coefficients that characterize the spectral optical properties of pigments. We have documented this theory in a draft of a journal paper in progress.

Jeff Nixon of Shepherd provided us some of the details of their optical testing procedures for cool pigmented PVDF acrylic coatings on galvalume metal roofing. A primer coat (acrylic epoxy, 0.3 mils) contains an SrCrO₄ yellow pigment for adhesion and corrosion inhibition. Then they add a 10 mil wet coating (70 % minimum PVDF) containing the cool pigment, which dries to a thickness of about 5 mils. This is a thicker coating than what is used in production; they want a thick coating to reduce the sensitivity to the substrate. (The coating is partly translucent.) He observed that for standard samples, sample preparation (good pigment dispersion) is important and that the use of tint ladders (mixtures with white and/or black) can improve accuracy. Several companies sell software for colored coating design, but the software does not (yet) treat the infrared part of the spectrum.

After reviewing the papers by French et al., we made measurements on several pigmented samples using their procedure, namely spectral reflectance and spectral transmittance, with the specular (unscattered) component excluded. While there are advantages to the French et al. approach under certain special circumstances, such as the measurement of the reflectance of an absorbing (black) pigment layer, overall there is no net benefit for us to change our measurement procedure.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings

(No activity.)

2.4.3 Develop a Database of Cool-Colored Pigments

(No activity.)

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods

The review of literature is progressing. ISP Minerals has provided some useful information regarding manufacturing shingle granules. We are also in the process of making arrangements with BASF, 3M, and ISP Minerals to visit a few industrial sites (manufacturing of roofing materials) in the vicinity of the Bay Area.

2.5.2 Design Innovative Methods for Application of Cool Coatings to Roofing Materials

We prepared a few samples and measured their optical properties.

2.5.3 Accelerated Weathering Testing

(No activity.)

2.6 Field-Testing and Product Useful Life Testing

Rick Olson and consortium members of the Roof Tile Institute submitted a written agreement to ORNL for the supply of roof material and labor to set up two demonstration homes in the Sacramento area. The first roof will have a medium profile concrete tile with the black, slate bronze or charcoal gray Ferro oxide. The roof will be installed on a batten system. The second roof will be installed with identical conditions except the tile will not have the Ferro oxide. Hanson in Northern Ca will manufacture the tile for these roofs. Custom-Bilt Metals has also made a similar agreement to supply both labor and metal roofing of the same color as used for the tile roofs for two other demonstration homes.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

As stated in our previous monthly report, the Habitat for Humanity (HFH) will have four homes adjacent one another for demonstrating cool tile and cool metal roofing products in Sacramento. Three of the four homes were blitz built, and are waiting to be placed on site. However, the Sacramento municipality requires that the land be split into four lots, and the lead-time for approving the development may be upwards of five months. Therefore other opportunities are being pursued to help quicken the setup of the demonstration sites.

Terri-Lei Robertson of Tesh Construction, Larry Burkhardt, president and CEO of the Economic Resource Council in Grass Valley, and the Sacramento Municipal Utility District (SMUD) are all interested in working with ORNL and LBNL. Mike Evans Construction has plans to build twelve homes within the Sacramento city limits. Six homes will be built simultaneously starting in March, 03. Sewer and water are already installed, and architectural house plans are in review. Evans will finish the subdivision the following year with six more homes. Each house will have a footprint of about 1600 square feet. The walls will be insulated concrete foam (ICF) that SMUD is subsidizing in exchange for acquiring thermal performance data. The builder recently spoke with Hanson Roof Tile, Custom-Bilt Metals and ORNL, and is both interested and willing to work with ORNL and LBNL. This is an excellent opportunity to pursue, because of location and because of the possible synergistic involvement with SMUD.

2.6.2 Materials Testing at Weathering Farms in California

Seven sites have been selected for exposing metal, tile and asphalt shingle roof products in the diverse climates of California (Table 1). Custom-Bilt Metal, Steelscape, BASF, Monier Life Tile and Elk Corp. will field test "Cool Roof Color Materials" (CRCM) at their respective manufacturing facilities (Table 1). The California population is expanding rapidly in the Central Valley and around the LA basin, and the sites with Custom-Bilt and Elk will capture the effects of weather, urban pollution and the expanding population. These areas reflect a market with many new homes. Weathering sites with Steelscape, BASF and Monier Life Tile are located in existing densely populated areas, and represent the market for re-roofing existing homes. Samples will also be exposed near weather stations maintained by the California Irrigation Management Information System (CIMIS). Sites in McArthur and Blythe, CA were selected for acquiring exposure data in the more extreme climates. McArthur is located in the moderate alpine climate of northern California

(climate zone 16); Blythe is in the extremely hot desert climate of southern California bordering the Arizona state line (climate zone 15).

Table 1. Weathering Sites for exposing the CRCMs in the diverse climates of California.

Company	Contact	Street Address	City	ZIP Code	County	Climate Zone
Custom-Bilt	Don Bonnington (916) 372-7696	1347 Shore Street	Sacramento	95691	Sacramento	12
Steelscape	Bruce Hopkins (510) 262-4858	2995 Atlas Road	Richmond	94806	Contra Costa	3
BASF	Michelle Vondran (909) 825-6292 Ext 309	1231 S. Lincoln St.	Colton	92324	San Bernadino	10
Monier Life Tile	(949) 756-1605	7575 Irvine Ctr.	Irvine	92618	Orange	8
ELK Corporation	Gus Freshwater (661) 391-3906	6200 Zerker Road	Shafter	93263	Kern	13
Department of Water Resources CIMIS	Jamie Dubay (530) 529-7367		McArthur		Shasta	16
Department of Water Resources CIMIS	Sergio Fierro (818) 543-4652		Blythe		Riverside	15

The CIMIS web site <http://www.cimis.water.ca.gov/> has current weather data for use in correlating the loss of reflectance of samples exposed at the field sites in Table 1. In fact, CIMIS has 118 computerized weather stations acquiring hourly data of solar irradiance, ambient air temperature and relative humidity as well as wind speed, wind direction and precipitation for helping agricultural growers judge when to irrigate and how much water to apply. Hourly, daily, weekly and or monthly data can be down loaded for developing correlations for the loss of reflectance.

2.6.3 Steep-slope Assembly Testing at ORNL

The metal consortiums working with ORNL have completed their painted metal study conducted at ORNL, and have tentatively agreed to let ORNL use the existing steep-slope assembly for testing tile and metal roof products painted with CRCMs. Miller will attend the Cool Metal consortium meeting in January, 03 to finalize the agreement with metal roof participants.

The tile consortium wants a steep-sloped roof assembly for measuring the cool roof properties of 5 different tile assemblies. Test sections will be 4 feet wide by 14 feet high, and will be configured with the tiles listed in Table 2.

Table 2. Clay and Concrete tile proposed by the Roof Tile Institute for the test stand at ORNL.

	Type of Tile	Producer	Application	Color
1	Clay "S"	MCA	Direct Deck	Terracotta
2	Concrete Medium	Hanson	Direct Deck	Black -Ferro
3	Concrete "S"	Eagle	Batten	Slurry Terra Cotta
4	Concrete Flat	Monier Life Tile	Counter Batten	Brown
5	Concrete Medium	Monier Life Tile	Direct Deck w/foam	Slurry Terra Cotta

The deck configuration for installation will be left to right – 1,2,5,4,3 . This will allow the best opportunity for tile heights to match up in helping to seal the individual

cell roof areas. A small bead of foam will be placed vertically between the 5 panel areas. A bead of foam will be applied between each panel section to limit airflow between panels.

2.6.4 Product Useful Life Testing
(No activity.)

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

Akbari and Desjarlais presented seminars on application of cool roofs in California in a meeting of the Roofing Industry Committee on Weather Issues (RICOWI) on November 15, 2002.

2.7.2 Market Plan
(No activity.)

2.7.3 Title 24 Code Revisions

Based on some comments made by roofing contractors at November 15 meeting of RICOWI, Pennington and Akbari made modifications to the proposal for revision of Title 24 for cool roofs on existing non-residential low-sloped roofs.

Management Issues

- None

Attachment 1

Project Tasks and Schedules (Approved on May 16, 2002)

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 11/30/2002
1	Preliminary Activities					
1.1	Attend Kick Off Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> Written documentation of meeting agreements and all pertinent information (Completed) Initial schedule for the Project Advisory Committee meetings (Completed) Initial schedule for the Critical Project Reviews (Completed) 	5/16/02	5/16/02	6/1/02	6/10/02	100%
1.2	Describe Synergistic Projects <i>Deliverables:</i> <ul style="list-style-type: none"> A list of relevant on-going projects at LBNL and ORNL (Completed) 	5/1/02	2/1/02	5/1/02	5/1/02	100%
1.3	Identify Required Permits	N/A		N/A		
1.4	Obtain Required Permits	N/A		N/A		
1.5	Prepare Production Readiness Plan	N/A		N/A		
2	Technical Tasks					
2.1	Establish the project advisory committee <i>Deliverables:</i> <ul style="list-style-type: none"> Proposed Initial PAC Organization Membership List (Completed) Final Initial PAC Organization Membership List PAC Meeting Schedule (Completed) Letters of Acceptance 	6/1/02	5/17/02	9/1/02		95%
2.2	Software standardization <i>Deliverables:</i> <ul style="list-style-type: none"> When applicable, all reports shall include additional file formats that will be necessary to transfer deliverables to the CEC When applicable, all reports shall include lists of the computer platforms, operating systems and software required to review upcoming software deliverables 	N/A		N/A		

Project Tasks and Schedules (contd.)

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 11/30/2002
2.3	PAC meetings <i>Deliverables:</i> <ul style="list-style-type: none"> • Draft PAC meeting agenda(s) with back-up materials for agenda items • Final PAC meeting agenda(s) with back-up materials for agenda items • Schedule of Critical Project Reviews • Draft PAC Meeting Summaries • Final PAC Meeting Summaries 	9/1/02	6/1/02	6/1/05		13% (1/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance <i>Deliverables:</i> <ul style="list-style-type: none"> • Pigment Characterization Data Report 	6/1/02	6/1/02	12/1/04		~ 14%
2.4.2	Develop a Computer Program for Optimal Design of Cool Coatings	11/1/03		12/1/04		
2.4.3	<i>Deliverables:</i> <ul style="list-style-type: none"> • Computer Program 	6/1/03		6/1/05		
2.5	Develop a Database of Cool-Colored Pigments <i>Deliverables:</i> <ul style="list-style-type: none"> • Electronic-format Pigment Database 					
2.5.1	Development of prototype cool-colored roofing materials Review of Roofing Materials Manufacturing Methods <i>Deliverables:</i> <ul style="list-style-type: none"> • Methods of Fabrication and Coloring Report 	6/1/02	6/1/02	6/1/03		~ 40%
2.5.2	Design Innovative Methods for Application of Cool Coatings to Roofing Materials <i>Deliverables:</i> <ul style="list-style-type: none"> • Summary Coating Report • Prototype Performance Report 	6/1/02	6/1/02	12/1/04		< 3%
2.5.3	Accelerated Weathering Testing <i>Deliverables:</i> <ul style="list-style-type: none"> • Accelerated Weathering Testing Report 	11/1/02		6/1/05		

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 11/30/2002
2.6	Field-testing and product useful life testing					
2.6.1	Building Energy-Use Measurements at California Demonstration Sites <i>Deliverables:</i> <ul style="list-style-type: none"> • Demonstration Site Test Plan • Test Site Report 	6/1/02	9/1/02	10/1/05		< 7%
2.6.2	Materials Testing at Weathering Farms in California <i>Deliverables:</i> <ul style="list-style-type: none"> • Weathering Studies Report 	6/1/02	10/1/02	10/1/05		
2.6.3	Steep-slope Assembly Testing at ORNL <i>Deliverables:</i> <ul style="list-style-type: none"> • Whole-Building Energy Model Validation Presentation at the Pacific Coast Builders Conference • Steep Slope Assembly Test Report 	6/1/02	10/1/02	10/1/05		< 7%
2.6.4	Product Useful Life Testing <i>Deliverables:</i> <ul style="list-style-type: none"> • Solar Reflectance Test Report 	5/1/04		6/1/05		
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer <i>Deliverables:</i> <ul style="list-style-type: none"> • Publication of results in industry magazines and refereed journal articles • Participation in buildings products exhibition, such as the PCBC Brochure summarizing research results and characterizing the benefits of cool colored roofing materials 	6/1/03		6/1/05		
2.7.2	Market Plan <i>Deliverables:</i> <ul style="list-style-type: none"> • Market Plan(s) 	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions <i>Deliverables:</i> <ul style="list-style-type: none"> • Document coordination with Cool Roofs Rating Council in monthly progress reports • Title 24 Database 	6/1/02	5/16/02	6/1/05		~ 5%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 11/30/2002
VII	Critical Project Review(s) <i>Deliverables:</i> • Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports <i>Deliverables:</i> • Monthly Progress Reports	6/1/02	6/1/02	6/1/05		13% (6/36)
XII (D)	Final Report <i>Deliverables:</i> • Final Report Outline • Final Report	3/1/05		10/1/05		
	Final Meeting <i>Deliverables:</i> • Minutes of the CPR meeting	10/15/05		10/31/05		